EMPHASIS ON NITROGEN IN FERTILIZERS

By D. P. HOPKINS, B.Sc., F.R.I.C.

THERE are few commodities, except entirely new ones, whose use in the past 20 years has expanded as boldly as fertilizers. For each ton used in 1939 by United Kingdom farmers, three tons are used now.

In a chemical and fundamental sense, to-day's fertilizers do not differ from those of the 1930s. The nitrogen used is still mainly sulphate of ammonia, with ammonium nitrate in second and rising place. Phosphate use is still dominated by superphosphate, and potash remains largely based upon muriate of potash. But there have been far-reaching technological advances—most notably that of granulation. Pioneered in 1931 when I.C.I.'s CCF compounds were first introduced, granulation entered the industry more widely in the latter part of the last war. By the end of the 1940s the major proportion of compounds was being made in this form, which is suitable for drills and is more easily stored.

A second and notable advance was the initiation of large-scale triple superphosphate manufacture by Fisons at their Immingham works in 1951. Since then, other manufacturers have also become triple superphosphate producers. The advent of this "stronger" phosphatic type together with granulation has enabled the compounds of the 1950s to contain much more plant-food per ton.

CHANGE IN PROPORTION

It is ironic that the main effect of having this more concentrated phosphatic fertilizer has been that of raising the nitrogen and potash contents of compounds. This has been a matter of requirement or consumer-demand. Phosphate dominated pre-war use. In 1939 the U.K. ratio for nitrogen : phosphate : potash use was 1:3:1; now it is about 1:1½:1. It is too broad a summary to say that we are using three times as much fertilizer as before the war. In fact, we are using five times as much nitrogen, four and a half times as much potash, but only slightly more than twice as much phosphate. This faster expansion of nitrogen and potash use has particularly occurred in the 1950s, during which annual phosphate use has changed very little whereas nitrogen and potash have shown 70 per cent. expansions. This trend seems certain to continue. Much of our research and most advisory experience leads to the view that phosphate is adequately provided for arable soils and crops by present rates, and that it is with nitrogen and potash rates that there is so often room for improvement.

MORE WITH SAFETY

Fertilizer practice with the modern, strong-strawed wheat and barley varieties provides a clear example of this. Nitrogen has long been timidly used on older varieties for fear of tall stems and lodging. The new varieties can not only be given more nitrogen with safety, but if they are not given quite high amounts of nitrogen their greater grain productivity cannot be exploited. It is becoming more evident, too, that all or most of this nitrogen may be applied to the seed-bed with spring-sown crops.

A survey of all 1945-55 experimental results in England and Wales has shown that the optimum (*i.e.*, most profitable) nitrogen rates per acre for modern high-responding wheats are 0.65 cwt. (winter) and 0.53 cwt. (spring); and for modern barleys, 0.70 cwt. These rates are equivalent to about 3½, 2½, and 3½ cwt. per acre of sulphate of ammonia. The value of expectable yield gains ranges from £8 to £10 an acre, after deducting fertilizer cost. These figures come from a joint Rothamsted-N.A.A.S. examination of measured results with cereals in different years and areas. They apply to all but the wettest districts.

As nitrogen rates rise, a higher use of potash also becomes more necessary, especially on the lighter soils. A mechanized and labour-saving agriculture will usually find it more economic to apply as much as possible of the nitrogen, plus a maintenance phosphate dressing, and complementary potash, in one combine-drilled operation as a high-analysis compound. At present, according to recent market research by Fisons, about 70 per cent. of the cereal acreage receives a compound.

Fertilizer use on grassland is lower and much less consistent than upon arable soils. Assessments vary but it seems certain that, except in Scotland, as much as 60 per cent. of our permanent grass is untreated. Even including the better-treated temporary grass, surveys have shown that half the acreage cut for hay or silage is not given nitrogen. Much more of the 1939-59 expansion has taken place for arable crops than for pastures; 1957 surveys showed that the total increase in fertilizer use from 1953 to 1957 was largely accounted for by arable crops, less markedly by applications to leys, and hardly at all by use on grass.

This is the background to the several new and large-scale manufacturing developments in the fertilizer industry. In late 1958 and 1959 new plants have been opened by I.C.I., by Shell, and by Fisons. Some commentators anticipate a marketing battle between giants. A less dramatic view seems more logical. These are timely and long-term ventures to provide the expanding needs of the future and also to improve products.

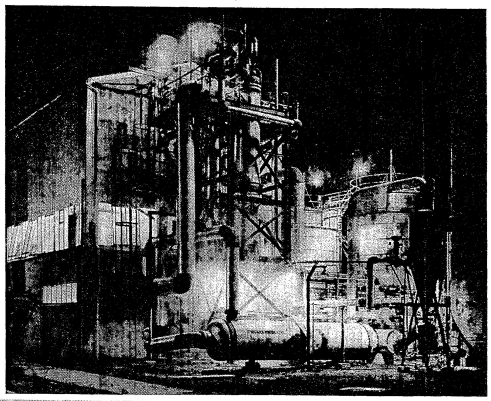
I.C.I.'s Billingham CCF granulation plant (left) and storage silo (right).

The new I.C.I. plant at Billingham is a continuation of former policy, a larger and more modern unit to manufacture the CCF compound, 12-12-18. Like the first CCF products of 1931, this derives its high plant-food content from the use of ammonium phosphate, in turn made from phosphoric acid and ammonia from air-nitrogen fixation. It is no secret that for many years the output of I.C.I.'s CCF compound has been limited by plant capacity. The entirely new plant can produce about 1,000 tons a day, and the man-hours needed a ton of output have been reduced by a third. In 1957/58 the sales of CCF compounds were about 250,000 tons. Probably, therefore, the new plant adds some 50 per cent. to the former maximum output. Added to this, a new plant at Leith, for I.C.I.'s subsidiary company, Scottish Agricultural Industries, began operating in 1958; all the CCF tonnage used in Scotland can be produced at Leith, leaving the new Billingham plant's production for England and Wales.

NEW FACTORY

Officially opened last summer, the new Shell factory on the Thames Estuary in Essex (Shellhaven) is based, like Billingham, upon the fixation of the air's nitrogen. But oil instead of coal is used both for the high fuel needs of this process and as the source of hydrogen for forming the ammonia from the nitrogen. The development of a large oil-refining industry here has made this possible. The new plant has an annual capacity of 75,000 tons of ammonia; 15,000 tons will be used to make "Nitra-Shell," until now imported from Holland, where it is made by another Shell Group factory.

Like I.C.I.'s "Nitro-Chalk," made at Billingham since 1929, "Nitra-Shell" is a granular combination of ammonium nitrate and chalk, the chalk being used to subdue the troublesome moisture-absorbing properties of ammonium nitrate. The ammonium nitrate is made from ammonia by oxidizing ammonia to nitric acid and then neutralizing this acid with more ammonia. The differing nitrogen contents of "Nitro-Chalk" and "Nitra-Shell" are matters of decision as to the proportions of ammonium nitrate and chalk used. Fifteen thousand tons of ammonia should provide rather more than 60,000 tons a year of "Nitra-Shell"; the new works has an off-season storage capacity for 20,000 tons. The small labour force is remarkable. Only about 80 people are employed to make the 75,000 tons of ammonia and to convert 15,000 tons of this into "Nitra-Shell." Yet this addition to United Kingdom nitrogen output represents nearly one-fifth of our present annual nitrogen fertilizer consumption.



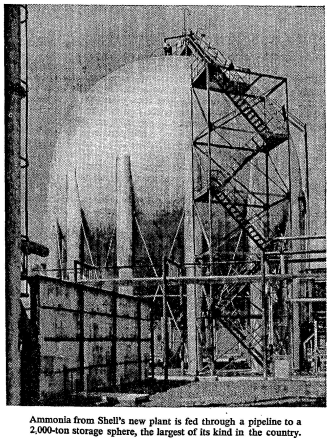
Night view of Fisons' nitric acid plant, showing compressor house in which air for mixing with ammonia is filtered and compressed.

The ammonia not used for making "Nitra-Shell" is pipe-lined in liquid form to the new and adjacent Fisons' factory at Stanford-le-Hope. There it is converted into ammonium nitrate. The daily output is about 400 tons, and annual capacity will be 140,000 tons. The plant requires an insignificant amount of power once started, for its operation is self-sustained by the energy released in the reactions by which ammonia is converted into ammonium nitrate.

By far the most interesting development is the handling of the ammonium nitrate produced. It is handled in the liquid form of a very strong aqueous solution—88 per cent. ammonium nitrate, 12 per cent. water. This solution solidifies by crystallization at 85deg. Centigrade—it must be kept well above this temperature if it is to remain fluid and thus be easier to transport. At the Stanford-le-Hope works it is stored at a temperature of 120deg. C. It is being used as a source of nitrogen for Fisons' more concentrated compounds, which are made at their factories in Devon, Essex, Gloucestershire, Lancashire, Lincolnshire, Suffolk, and Yorkshire. It is sent to these works by fleets of road tankers or rail wagons, in which steam-coil heating keeps the hot solution well above its crystallizing temperature.

Until now the nitrogen in this company's compounds has been based upon sulphate of ammonia, which contains 20.8 per cent. of nitrogen: ammonium nitrate contains 35 per cent. This development, like the earlier one of triple superphosphate, will enable compounds to be made with higher plant-food contents. For 1959/60 Fisons have announced two additions to their "40" range, one with 16 per cent. of nitrogen, the other with 14 per cent. It is expected that on many soils these particularly high-in-nitrogen compounds will provide the full needs of spring cereals in one seed-bed dressing, eliminating the cost of further top-dressing.

Huge capital investments in these new plants show the industry's confidence in the further expansion of British fertilizer use—with marked emphasis upon nitrogen. Despite 1939-59 expansion, farmers in seven other European countries use considerably more nitrogen an acre than we use—Holland three and a half times as much an acre, western Germany one and a half times as much. The major producers are looking ahead—as in 1931 when the first CCF fertilizers were made, as in the later 1940s when granulation of compounds was so widely introduced, and as in 1951 with triple superphosphate. These advances have not meant higher costs to farmers; rather, they have helped in the absorption of rising charges. In the past seven years production costs have risen by over 40 per cent.; fertilizer prices have risen by only 21 per cent.



Ammonia from Shell's new plant is fed through a pipeline to a 2,000-ton storage sphere, the largest of its kind in the country.

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